



06/30/1999

**FINAL REPORT**

**TECHNOLOGY DEMONSTRATOR FOR DIRECT POLISHING OF A 50CM C/SiC ULTRA LIGHT MIRROR  
MARSHALL SPACE FLIGHT CENTER**

**NASA CONTRACT # NAS8-98242**

**CONTRACTOR: GENERAL OPTICS, INC.**

**1) Schedule of Events:**

- Contract let date – 9/25/98
- Receipt of the C/SiC substrate at General Optics, Inc. – 10/2/98
- Complete NRSU – 12/25/98
- Complete substrate lapping – 3/25/99
- Complete substrate polishing – 6/15/99
- Inspected and shipped – 6/22/99

**2) Planned Activities Related to NRSU:**

All planned activities related to NRSU have been completed.

**3) Planned Activities Regarding the C/SiC Substrate Fabrication:**

**A) C/SiC Substrate Lapping:**

The lapping of the 50cm diameter C/SiC substrate began on 1/4/99 and was completed on 2/18/99.

Approximately 5 weeks of "rough" diamond lapping was required for the entire surface of the part to come into plane. The original shape received was somewhat cylindrical (fig 1). The average face plate thickness at that time as measured at 4 places equally spaced on a 12.5cm radius from center, was 2.0mm. Two voids separated by approximately 25mm remained in the surface near the outside edge. One was approximately 2.5mm x 4mm and the other approximately 1.5mm x 2.5mm. Since the depth of these voids was estimated at .25mm, and because we had reached the estimated face plate thickness of 2mm, it was decided to proceed to the fine lapping operation, so as to not further diminish the structural integrity of the part.

Approximately one week was required to "fine" diamond lap the part. The face plate thickness was 1.9mm at the completion of "fine" lapping, and is not expected to be reduced significantly at polish.

The above mentioned voids were still present, and the decision was made to proceed to the polishing operation for the same reasons.

***B) C/SiC Substrate Polishing.***

The polishing of the C/SiC substrate began on 2/22/99, and was completed on 6/15/99.

Once the part was "polished out" (fig 2), an initial surface inspection was performed. The surface exhibited the same "mottled" look as the 3"Ø coupons of the same material that were polished during the bidding portion of this contract. The two aforementioned voids have not caused any problems during the polishing operation. One defect in the material, approximately 5mm long was discovered in the surface, approximately 75mm out from the center of the substrate.

Once the part was polished, it became possible to use the 9"Ø, 20 Meter convex test plate to measure the radius of the substrate. Once a few measurements were made, we began to feel that a larger test plate would give us a better tool to measure our goal of polishing the C/SiC substrate to "diffraction limited performance at 2 microns".

For this reason, we made the decision to make a 16"Ø Pyrex, 20 Meter convex test plate from a blank that we had in house, and to fabricate a light box that would allow us to set the C/SiC substrate on top of the test plate, to minimize distortions caused by weight. For the same reason, we drilled a hole through the center of the test plate and plumbed an air line to the test plate, to allow the part to sit on a cushion of air. This prevents distortion caused by "point loading". This has proved to be an effective way of measuring the radius and sphericity of the surface of the substrate.

The cost of the 16"Ø test plate and of the light box will not increase the contract total price. The cost will be borne by General Optics, Inc.

The surface quality of the part was inspected after the completion of the polishing process. The surface quality remained the same as described above at initial surface inspection.

The optical figure was measured on the 16"Ø test plate and light box described above. Photos were taken of the interference patterns in the (fig 3) horizontal, (fig 4) vertical, and (fig 5) diagonal orientation. Visual observation shows the figure error to be approximately 1 fringe peak to valley, plus 1 fringe irregular, or a total of approximately 2 fringes figure error over the 16" test area shown. This is approximately 1 wave at 530nm test wavelength, or approximately  $\lambda/3.8$  at 2 microns.

A meeting was held at General Optics, Inc. on 6/22/99, with Greg Mehd of Composite Optics, Inc. to discuss several NGST issues, including this substrate. Upon completion of the meeting, the substrate was packaged in the wooden box that it was received in, and was hand-carried by Greg to Composite Optics, Inc. for further inspection, and possibly cladding.



**4) Summary**

The NRSU portion of the contract was completed on schedule and within acceptable limits of the estimated cost.

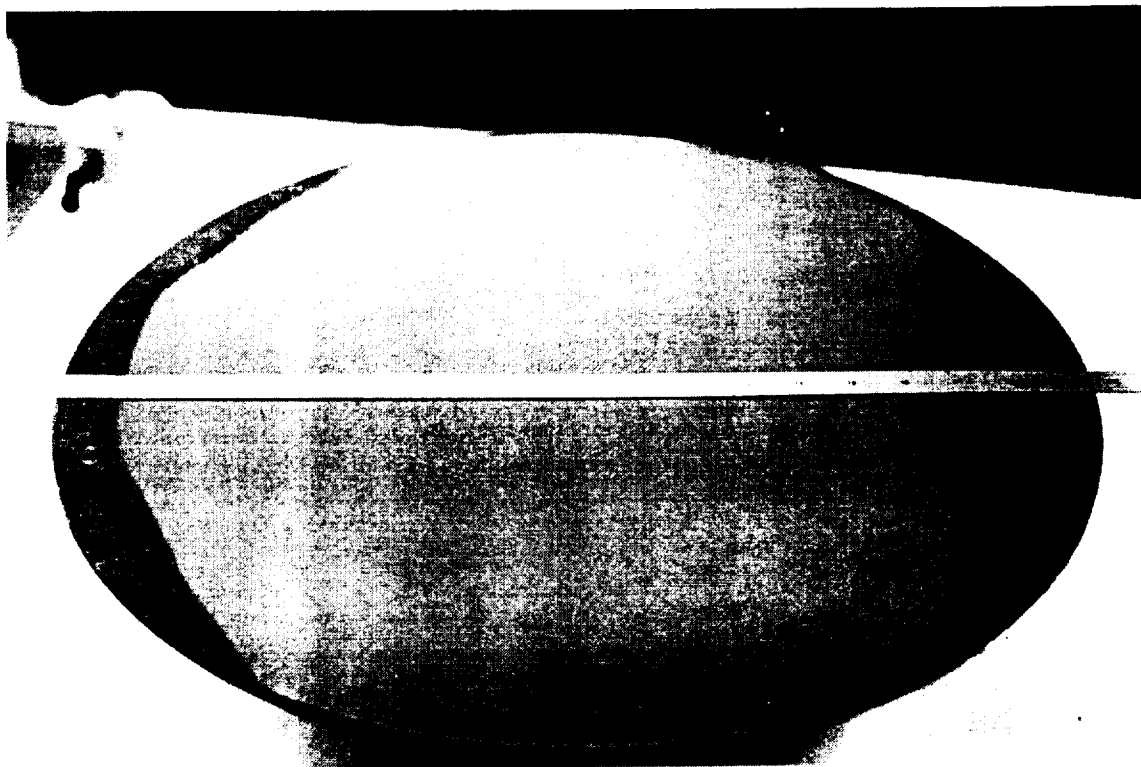
The lapping of the substrate started on schedule, and completed ahead of schedule.

The polishing of the substrate was begun ahead of schedule, and was completed approximately one month ahead of schedule.

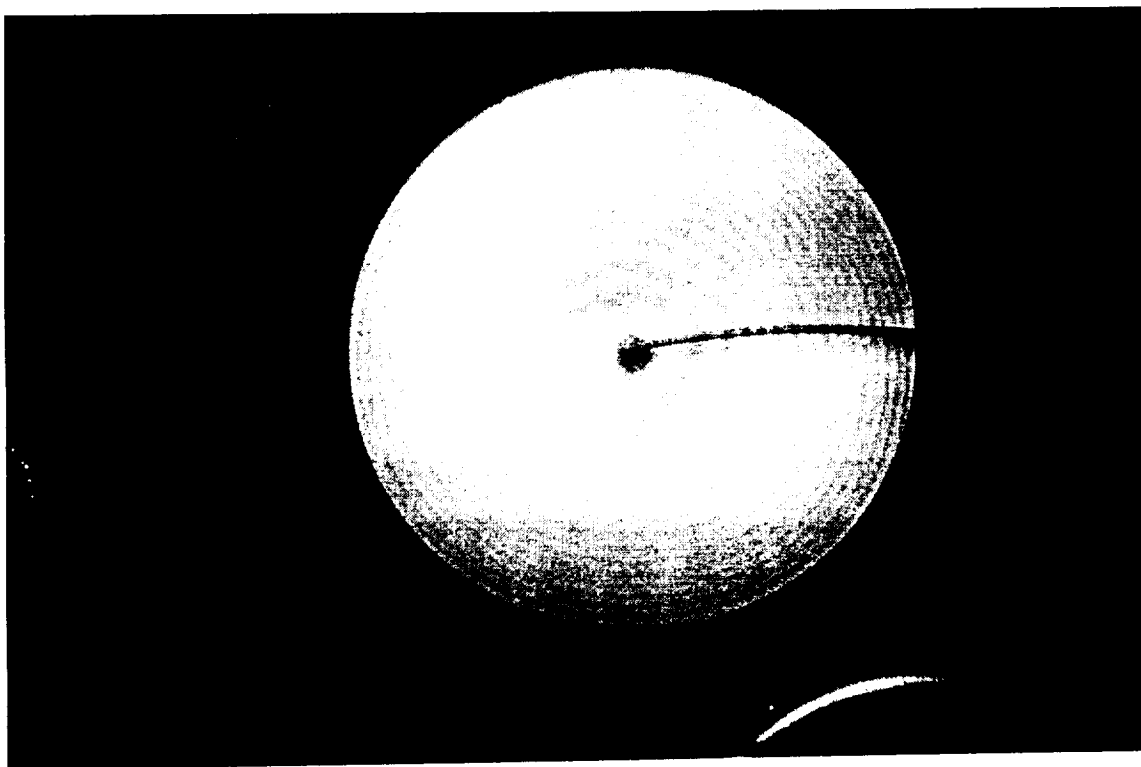
It is our opinion that the substrate meets the requirements of "diffraction limited performance at 2 microns" over the measured 16" area. The final photos (fig 3 thru 5) suggest that there may be edge roll-off beyond the 16" diameter. However, we cannot quantify this.

It is our opinion that this material is suitable for use in lightweight optics as long as cladding of some type is used (Silicon, SiC, Sol-Gel, etc), as the bare material itself is too "porous" to obtain a high quality finish.

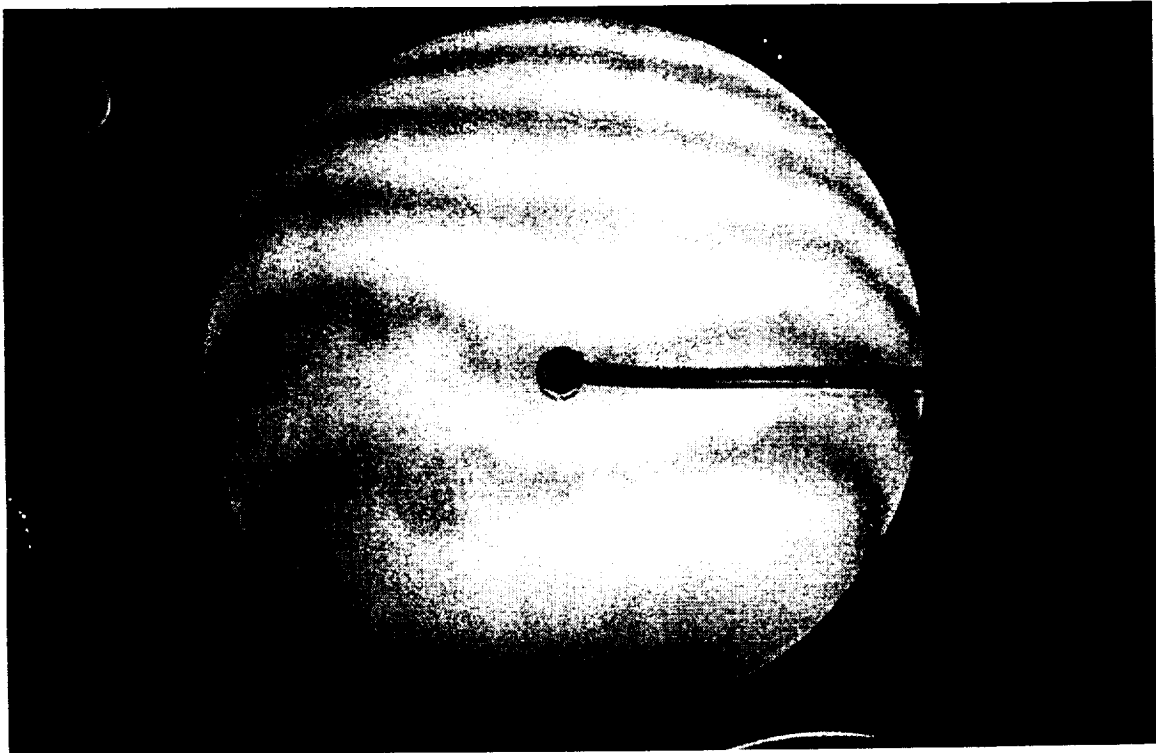
We feel that this part was at the low limit of structural integrity required to mechanically polish to this level of figure requirement. Any lesser structural integrity would require some form of "non contact" figuring to attain this level of figure.



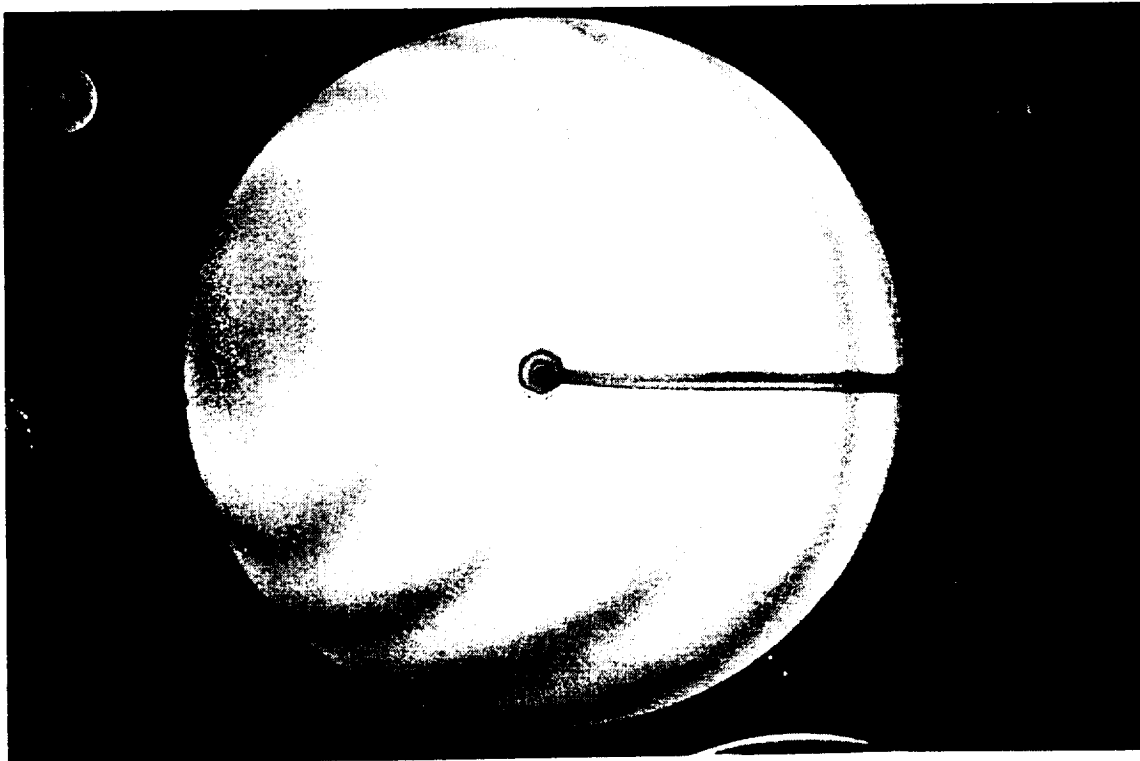
(fig 1)



(fig 2)



(fig 3)



(fig 4)



(fig 5)

# REPORT DOCUMENTATION PAGE

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